

# Biofuels Development Program's Biodiesel R&D

Replacing petroleum-based diesel fuels  
with a cleaner, renewable, domestically  
produced alternative

U.S. DEPARTMENT  
OF ENERGY

OFFICE OF  
TRANSPORTATION  
TECHNOLOGIES



## Transportation FOR THE 21ST CENTURY

Most of our Nation's trucks, buses, and ships rely on the efficiency, cost-effectiveness, and reliability of heavy-duty diesel engines, powered primarily by diesel fuel that is made from imported petroleum. Our Nation's economy is dependent on trucks and the diesel fuel they use to move most of the goods and services that support our standard of living. Diesel fuel has its problems, however, especially with regard to the environment. Developing reliable, clean, domestic substitutes for petroleum diesel, such as biodiesel, will eliminate the environmental problems currently associated with conventional diesel fuel. Because it can be made in the United States, biodiesel will also increase our energy security and help ensure a healthy economy for future generations.

### **Biodiesel is energy efficient, offers cleaner air, and reduces greenhouse gases**

Each gallon of biodiesel, made from vegetable oil and methanol, displaces nearly a whole gallon (actually 0.95 gallon) of petroleum diesel over its life cycle. (A life cycle is a cradle-to-grave analysis of all the activities involved in making a fuel.) Biodiesel is also very energy efficient. For every unit of fossil energy used to produce biodiesel, 3.37 units of biodiesel energy are made.

There are health concerns linked to breathing air that contains diesel fuel emissions. Pure biodiesel reduces sulfur dioxide by 100 percent, carbon monoxide by 43 percent (a wintertime pollutant), particulates by 55 percent, and hydrocarbons by 56 percent compared to emissions from petroleum diesel. Twenty percent biodiesel (B-20) reduces carbon monoxide 13 percent, particulates 18 percent, and hydrocarbons 11 percent. A portion of current research is a joint effort of the U.S. Departments of Energy and Agriculture directed toward reducing nitrogen oxides in biodiesel.

Carbon dioxide (CO<sub>2</sub>) is a major greenhouse gas that has been linked to global climate change. All growing plants sequester CO<sub>2</sub> from the atmosphere and when biodiesel oil produced from oil seed crops is finally burned, the CO<sub>2</sub> is released. However, this recycling process reduces the amount of CO<sub>2</sub> released by burning biodiesel by 78 percent compared to the burning of petroleum diesel.

Biodiesel can be used neat (100 percent biodiesel) or can be blended with diesel fuel in any proportion to improve diesel fuel emissions. Even small amounts of biodiesel improve diesel fuel characteristics. Twenty percent biodiesel (B-20) is most frequently used in U.S. medium- and heavy-duty trucks.

### **Biodiesel does not require new infrastructure**

Biodiesel can be stored in diesel tanks, pumped with regular equipment, and used in existing diesel engines with only minor changes to engine components such as rubber seals and gaskets.

### **Biodiesel is used in fragile environments**

Because biodiesel is nontoxic and biodegradable, it is an excellent fuel for use in fragile environments such as estuaries, lakes, rivers, and national parks. The 1998 Winter Olympics used biodiesel-fueled shuttle buses to protect the fragile environment around Nagano, Japan. That biodiesel was made from recycled cooking grease using state-of-the-art U.S. technology and expertise.

### **Users like biodiesel**

Surveys of customers using biodiesel have been very favorable. The only concerns with biodiesel use that have been noted are its stability during storage and its cold-weather performance, both of which can be solved by



*Soybean biodiesel-powered bus  
in Nebraska*

using additives or changing the fuel formulation. The major drawback is that biodiesel costs more to produce than diesel fuel, making the fuel impractical for widespread use in a competitive industry.

#### **Near-term improvements are sought**

To establish a vigorous, growing industry, OTT's Biofuels Development Program is coordinating research with the private sector and other Federal agencies to accomplish the maximum amount of progress in the near-term. OTT's partners include the U.S. Department of Agriculture, the National Biodiesel Board, biodiesel fuel suppliers, the Fats and Protein Research Foundation, the Diesel Engine Manufacturers, the American Railroad Association, and CSX Railroad.

Current projects fall into five research-priority areas: (1) Making biodiesel out of low-cost feedstocks, such as recycled cooking grease or tallow, and testing these new fuels; (2) developing test methods and standards for establishing biodiesel fuel quality; (3) reducing NOx emissions from the combustion of biodiesel fuels; (4) screening and developing new fuel formulations and additives to improve biodiesel fuel performance; and (5) conducting education and outreach to find and create new markets for biodiesel.

#### **The long-term goal is low-cost biodiesel**

The Fuels Development Program is also looking to the longer term, focusing on research approaches that can lead to permanent reduc-

tions in biodiesel costs. Currently, the cost savings created by using low-cost feedstocks are limited by the amount of feedstocks available. Since their costs will eventually rise as the demand for biodiesel increases, this will reduce future cost savings.

Our nation needs novel technologies that can lead to large-scale biodiesel production at a reasonable cost. To this end, the program has started a three-year project to develop an industrial mustard crop. Mustard oil can be produced for 11 cents per pound because it is not edible by humans or livestock, and it is not attractive for industrial chemicals. Its low value is perfect for making low-cost biodiesel (<\$1.00/gal). The crushed seeds left over after extracting the oil can be used as natural, organic pesticides, replacing many of the agricultural chemicals used today. The crop also produces large amounts of residues, which could be used to produce ethanol or biomass power. DOE has invested in a three-year breeding program that includes field demonstrations to evaluate this approach to biodiesel feedstock productions.

#### **Outreach programs are also underway**

The Biofuels Development Program and the California Air Resources Board (CARB) worked together to list biodiesel as a fuel additive for PM emission reductions in California. A consortium consisting of the National Biodiesel Board, several biodiesel producers, and the National Renewable Energy Laboratory are working to certify biodiesel emissions, including NOx reductions, with CARB this year.

**For more information on how  
DOE is helping America remain  
competitive in the 21<sup>st</sup> century,  
please contact:**

**Donna Hawkins**

Office of Transportation

Technologies

(202) 586-9389

[donna.hawkins@ee.doe.gov](mailto:donna.hawkins@ee.doe.gov)

<http://www.ott.doe.gov>



**January 2001**